Foreign applications at the Japan Patent Office – An empirical analysis of selected growth factors

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INTERNATIONAL PATENT EXTENSIONS: FOREIGN APPLICATIONS AT THE JAPAN PATENT OFFICE

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Abstract:
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ABSTRACT
This article aims to evaluate some of the possible factors which could have had a significant role in the increase in the yearly number of foreign patent applications at the Japan Patent Office. Starting from the 90 s, foreign applications increased constantly while the number of domestic filings remained almost the same or even decreased. The increase is more striking when compared to analogue figures for the US Patent and Trademark Office and the European Patent Office, where the same ratio didn t change too much in the same period.
The existing literature has recognized, not always unanimously, some factors affecting the propensity to file a patent application in a foreign country. A group of them is related to the innovativeness of the extending countries (Eaton and Kortum, 1996: Grupp and Schmoch, 1999: Furman et al., 2002: van Zeebroeck et al., 2009) while other authors have focused on the characteristics of the recipient country (Bosworth, 1984: Maskus, 1998: O Keefe, 2005). This paper tries to capture the relevance of such drivers in the increased amount of foreign patent applications at the JPO.
The innovativeness of the extending countries is measured through their wealth, size and research commitment, respectively proxied by GDP per capita, population and R&D expenditures. The attractiveness of the recipient country is similarly indexed by analysing its wealth, market size and the peculiarities of the national patent office in charge to process international patent applications. With these considerations, Japan is valuated by its GDP per capita, population, patent fee and the level of the harmonization of Japan patent system compared to each extending country, by evaluating the Ginarte and Park patent protection index (1997 and 2008).
The dependent variable is the number of patent application filed at the JPO by each country per every year from 1991 to 2005. The data have been collected from the JPO Annual Reports. Since it can assume only positive integer values and it is affected by overdispersion I decided to use a negative binomial model for panel data. In order to take in consideration possible missed differences among countries, I opted for a fixed effects regression. To control for the involvement of each extending country in Japan economy, I considered the level of FDI and of trade to Japan from each originating nation and the proximity in terms of filed patents at the USPTO

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Working paper

"International Patent Extensions: Foreign Applications at the Japan Patent Office"

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ABSTRACT

This article aims to evaluate some of the possible factors which could have had a significant role in the increase in the yearly number of foreign patent applications at the Japan Patent Office. Starting from the 90's, foreign applications increased constantly while the number of domestic filings remained almost the same or even decreased. The increase is more striking when compared to analogue figures for the US Patent and Trademark Office and the European Patent Office, where the same ratio didn't change too much in the same period (TSR, 2008). Building on previous literature, this paper analyzes the impact of some macroeconomic and structural characteristics of the extending country, on one side, and, on the other side, some features specific to the receiving country and its Patent Office (here Japan and the JPO). This work tries to capture the relevance of such drivers in the increased amount of foreign patent applications at the JPO.

1 Introduction

Following the path of economic globalisation, where emerging countries are rising fast and knowledge as a source of competitive advantage implies to pay greater attention on its protection, the number of international patents has grown significantly over the past two decades (TSR, 2006 and 2007; WIPO, 2008).

The relevance of patents extended abroad is rising for different stakeholders. The world largest patent offices have already launched several initiatives, such as the Foundations Project in the "Five IP Offices" Project[1] or the several bilateral agreements called "Patent Prosecution Highways", with the aim to create a common ground in terms of patent information, procedures and rules: the final goal is to speed the examination process, to reduce the patent backlog and to guarantee the stability of patent right. At the same time, the globalisation pushes firms to gain protection for their innovations in different countries: production sites may be in a different location from the destination market and even competitors may be in another region of the world.

A better understanding of the dynamics of the international extensions would improve the patent system.

In this article the foreign patent applications at the Japan Patent Office (JPO) are analysed. The JPO receives annually the largest number of patent filings and, since 1996, has reported a continuous increase in the ratio of foreign on domestic applications. The analyses on the data I collected from the JPO Annual Reports are performed by taking into account the drivers that the previous literature has recognized even if not always unanimously. The regression results suggests that the growth in

[1] For further details about the "Five IP Offices" Project: http://www.fiveipoffices.org

international filings at the JPO is positively related to the innovative capabilities of the extending countries and to the international harmonization of the patent systems.

2 Relevance of international patents

A patent is a form of intellectual property right (IPR) issued with a twofold perspective: on one side, to motivate inventors to share their knowledge and not keeping it secret; on the other side, any patent rewards its owner with a temporary monopoly power. The monopoly power which is assured is limited to the jurisdiction of the official institution in charge to grant or refuse patent issues: in general it overlaps with the boundaries of the IPR office country[2].
An international patent is a patent which has been filed reporting an assignee whose nationality is not the same of the examining and granting office. A more practical definition makes use of information on priority documents: if a patent or a patent application has a priority in another patent office, from a different country, it can be considered an international patent which has been extended from the first recipient country. Since in most of the cases[3], the applicants, that is the patent rights owners, decide to file the application in the country they reside in and to extend later the patent in all the countries they have interests to gain protection, the two definitions can be considered overlapping.
If we consider the assignee, the most common situation is the case of a firm that has already obtained, or is on the way to obtain, a patent in its home country and aims at obtaining another patent for the same invention in a foreign country. Such a firm may be looking for official protection of its exports from imitation, but it may also be pursuing more complex strategies according to the presence of affiliates, franchisers, allied firms, or competitors in the destination country.
In a few cases, international patents may be defined as such on the basis of the nationality of the inventor, rather than the assignee. In this case, any patent applied for in country A in order to protect an invention by an individual (inventor) from country B can be defined as international[4].

International patents have been used in economics and innovation literature as proxy of different measures, due to their peculiarities. Many studies agree that international patents can be considered as representatives of a *country's best inventions*, stressing their value in terms of inventiveness and radicality and of technology transfer. According to this assumption, Pavitt (1983) stated that the probability for a patented invention to be developed into a full-fledged innovation is higher for patents which are extended abroad, and especially to U.S., (the most technologically advanced country in the world, and still the biggest market). The same idea is shared by Evenson (1984), Dosi et al. (1990), Cockburn and Henderson (1994), Putnam (1995), Eaton and Kortum (1996 and 1999), Kortum (1997), Vertova (1999), Furman et al. (2002). The concept was refined by Watanabe et al. (2001), who agreed that patent applications to foreign countries, not granted patents only, provide a better demonstration of innovation for each of the respective countries.
As noted in Johnston and Carmichael (1981), since patents are one of the few output measures of innovative effort, they play an important part in guiding science and industry policy, since they are

[2] The most remarkable exceptions is the European Patent Office, covering nations belonging to the European Union and other neighbouring countries, and the World Intellectual Property Organization.
[3] van Zeebroeck et al. (2009), analyzing a dataset of one and a half million EPO applications filed between 1982 and 2004, found that a little more than 3% of the applications are filed in by non-US applicants thus reporting a US priority, and about 1.5% of applications are submitted by a US applicant with a non-US priority.
[4] When international patents are analyzed from the point of view of inventor's nationality, the focus is usually more on the topic of collaboration in international staffs, allowing to draw conclusions on the involved labour force, the kind of joint ventures and workforce mobility.

counted to indicate technological performance (Pavitt, 1985; Patel and Pavitt, 1991, 1995), and are expected to bear some relation to R&D expenditure (Pakes and Griliches, 1980; Griliches, 1990).
It is generally accepted that many companies (especially the large ones) find it relatively cheap and easy to file all sorts of patents, including those for inventions of unknown or untested value, in their home country[5]. On the contrary, filing patents abroad is so expensive (due to extra fees, translations costs, etc.) that application efforts are limited to highly valuable inventions.
International patents can be considered a *measure of the inventive output or of the innovative* effort more precise than the total number of patents. Since we have no direct measure of inventive output, patents are indirect evidence of research output, and where patent protection is sought reflects where inventors expect their ideas to be used (Eaton and Kortum, 1996). In the same study, the authors considered international patents as one of the indexes to measure productivity growth. They modelled productivity growth from inventive activity in different countries. Furman et al. (2002) addressed the issue of the economic growth focussing on the analysis of "national innovation capacity", that is the ability of a country to produce and commercialize a flow of new-to-the-world technologies over the long term: international patents were used as a direct component in measuring national innovation capacity. Furman et al. (2002), as in other studies such as Bosworth (1984), Maskus (1997), Branstetter et al. (2006), highlighted the disclosure function of patents[6] which allows to measure technology and knowledge transfer. International patents are more precise since they catch the real innovation due to high costs in going abroad: it is the true measure of innovation and of innovation worth to be "traded".

3 Motives to patent

The decision to ask for a patent grant in a foreign country is usually connected to receive official protection from imitation but it could be also rooted to strategic intentions according to the presence of affiliates or competitors in the destination country.
The traditional motive is to receive protection from imitation (Ordover, 1991). Protection can be sought because patent assignee targets the destination country as an existing or only potential market and to prevent imitators from copying and selling back (O'Keefe, 2005; Criscuolo, 2006; Yang and Kuo, 2008). The traditional motive apply also in the case when destination country is seen as a place where to establish new production plants[7] (Eaton and Kortum, 1996, O'Keefe, 2005; Yang and Kuo, 2008)[8].
Other reasons to apply for a patent in a foreign country are linked to competition in order to receive a grant where competitors produce or sell (Ordover, 1991). The aim is in this case to prevent competitors from patenting, that is to realize a blocking strategy in order to reduce competitor's space while defending own space (Eaton and Kortum, 1996; Blind et al., 2006). Patent portfolios serve to scare off new market entrants by creating patent fences[9].
With the opposite function to collaborate instead of compete, patents turn to be instruments to bargain, since they guarantee royalties from licensing and allow to acquire public or private funding

[5] See also Criscuolo (2006) for a deeper analysis of the "home advantage" effect.
[6] In relation to their disclosure function, patents can be considered as an input measure to innovation.
[7] Eaton and Kortum (1996) state that it specially holds where a limited investment is needed to manufacture the product, making it easy to shift manufacture in the destination country. A foreign patent allows to reduce damages from the risk of off-shoring: even if the country of manufacture may not be seen as a significant target market for the product, the mere fact that the production is located there may lead to copy-cat production facilities resulting from know-how and/or technology leakage (O'Keefe, 2005).
[8] Destination country might be not covered actually by any real interest but it could have been chosen in the batch of possible markets in the International or regional procedure, due to an initial uncertainty in defining the final market country.
[9] Different patenting strategies are often defined as pooling, stacking, blocking, flooding, clustering, bracketing, blietzkrieging, harvesting.

and to cooperate with other institutions and have positive reputational effects. In the work of Blind et al. (2006), the two most relevant motives are the improvement of the position in negotiations with other enterprises and preventing infringement lawsuits by third parties. Licensing income, accessing foreign markets and the internal evaluation of R&D productivity play significantly smaller roles. Ordover (1991) focused on the reasons and on the brakes to request patent protection. Among the motives which limit patent propensity, he noted that the preference can be on patenting but also on other strategies for technology exploitation, such as secrecy, market lead time[10] or even utility models (petty patents); moreover there might be a lack of competition, of patent culture or of management attention; patent assignees could have faced negative past experiences (for example trials ended with low damages) or evaluate the enforcement level inadequate (weak protection, absence of litigation).

4 The JPO in the international context

Japan has a population exceeding 120 millions inhabitants since the middle of 80's, a Gross Domestic Product (GDP) per capita among the world highest and, according to United Nations Human Development Index, it is one of the 10 most developed countries. All these characteristics should make the Japanese market very attractive in terms of size and consumption capacity and consequently attract patents also from foreign firms which could desire to protect the inventions which add value to their products. Besides, the country has scarce natural resources making it a traditionally investor on intangibles. In spite of this, the ratio of foreign on total patent applications has always been one of the lowest until the 90's.

Japan has always been considered a country where apply for a patent is hard for foreigners. Until the second part of the 90's the ratio of domestic on total patent application was constantly over 90%. Different reasons were claimed ranging from the strength and the ability in building entry barriers of Japanese groups of firms (the "Keiretsu"), to the unique and close IP system which allowed only applications in Japanese language and granted a low level of enforcement and damages, to the suspicion that Japanese tend to buy Japanese products and international brand cannot penetrate market (Ordover, 1991; Yang and Kuo, 2008)

In recent years, the Japanese IP system has been the subject of a series of law amendments which have deeply changed it. The most significant reforms have been the introduction of the possibility to file applications with more than one claim[11] in 1987, the accession to Trade-Related Aspects of Intellectual Property Rights (TRIPS)[12] agreement in 1995 and the launch of a Government-promoted policy aiming at making Japan an "IP-based nation": its starting point was the "Basic Law on IP" in 2002.

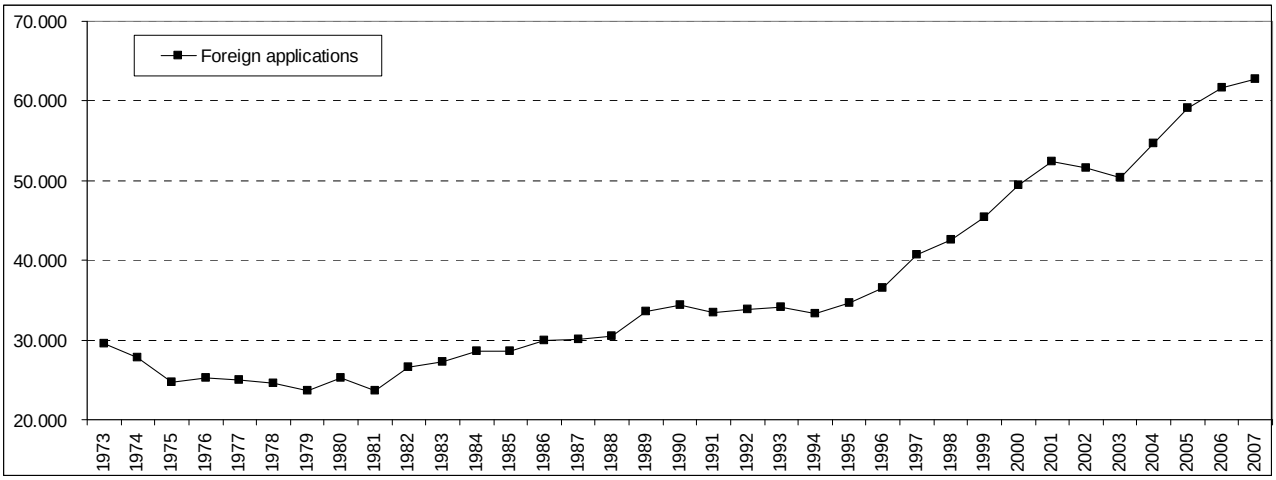
[10] Alternative forms of IP protection are often preferred to patents; see for example the works of Cohen et al. (2000 and 2002).

[11] In 1987, with the introduction of the "Revised System of Multiple Claims", a unique feature of the Japanese IP system was abolished: the "single claim requirement" on patent and utility model applications was eliminated. The former law encouraged several narrow applications, often centred on one novel invention. The number of claims in one application increased rapidly and, at the same time, there was a reduction in the growth of patenting: inventions that previously had to be filed as separate patent applications could now be filed as a single application with multiple claims (Goto and Motohashi, 2007). Although single claims are no longer a legal requirement, Japanese patent officers and firms still favour narrowly defined applications. On average, in 2007, an application filed at the JPO contained 9.8 claims (9.5 in 2006), one filed at the EPO contained 18.0 claims (18.2 in 2006), while one application at the USPTO had 20.1 claims (20.5 in 2006) (TSR, 2007). There still seems to be a tradition to have fewer claims in a single patent.

[12] Accession to World Trade Organization and related adhesion to TRIPS agreement pushed Japan to harmonize its IP system to the rest of the WTO members. The most relevant amendment was the possibility to file patent applications in English, sensibly reducing patent costs pending on foreign applicants.

The analysis of foreign patent applications counts shows a clear increase from 1996, following the process of harmonization started with TRIPS accession and a second boost in 2004, two years after the launch of the "IP-based nation" program (*Figure 1*).

Figure 1 Yearly foreign patent applications at the JPO (Source: JPO Annual Report, several edition)



In the same period, the EPO and the USPTO reported an increase in foreign patent application too (*Figure 2*). However, the increase in these two offices seems to be proportional to the general increase they faced in patent applications, both domestic and foreign. The ratio of foreign on total applications does not change much at the EPO and the USPTO while it keeps growing at the JPO, even if it is still much lower than its European and U.S. counterparts.
Figure 3 highlights the variation of the ratio of foreign on total filings in the three offices: the value in 1996 is the base (100%) and the following years are compared to it. Compared to the other two world most relevant patent office, USPTO and EPO, data on Japanese Office show some peculiarities. In terms of absolute numbers of international filings, yearly the JPO receives an amount comparable to the quantity filed in at the EPO and to one third of what is filed in at the USPTO. The ratio of foreign on total applications has scored around 45-50% for the EPO and the USPTO, quite constantly since 1995. On the contrary the ratio for the JPO increased in the period.

Figure 2 Yearly foreign patent applications at the JPO, the EPO and the USPTO (Source: TSR, from 2003 to 2008 edition)

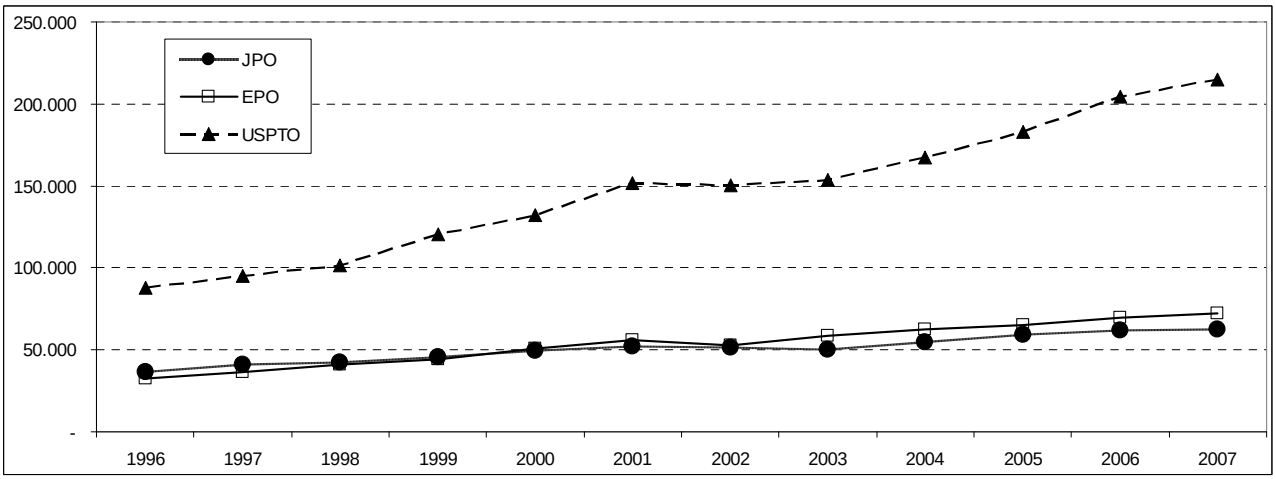
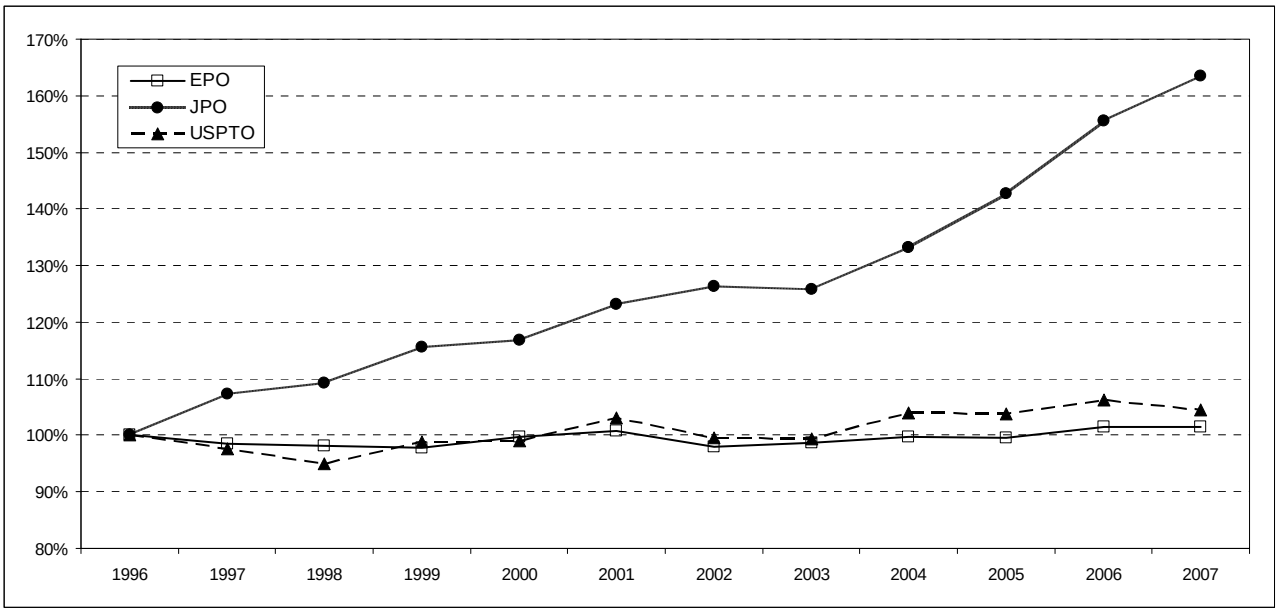
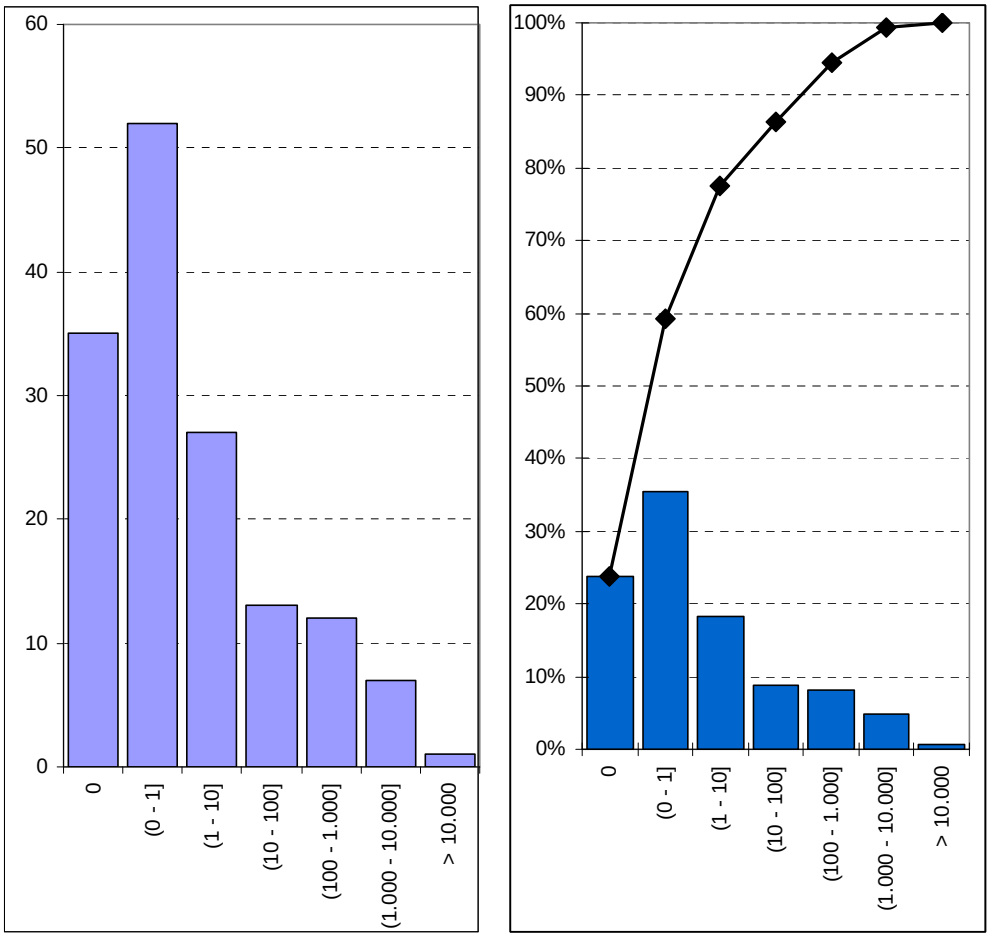


Figure 3 Ratio of foreign on total patent applications at the JPO, the EPO and the USPTO: variations from 1996 values (source: TSR, from 2003 to 2008 edition)



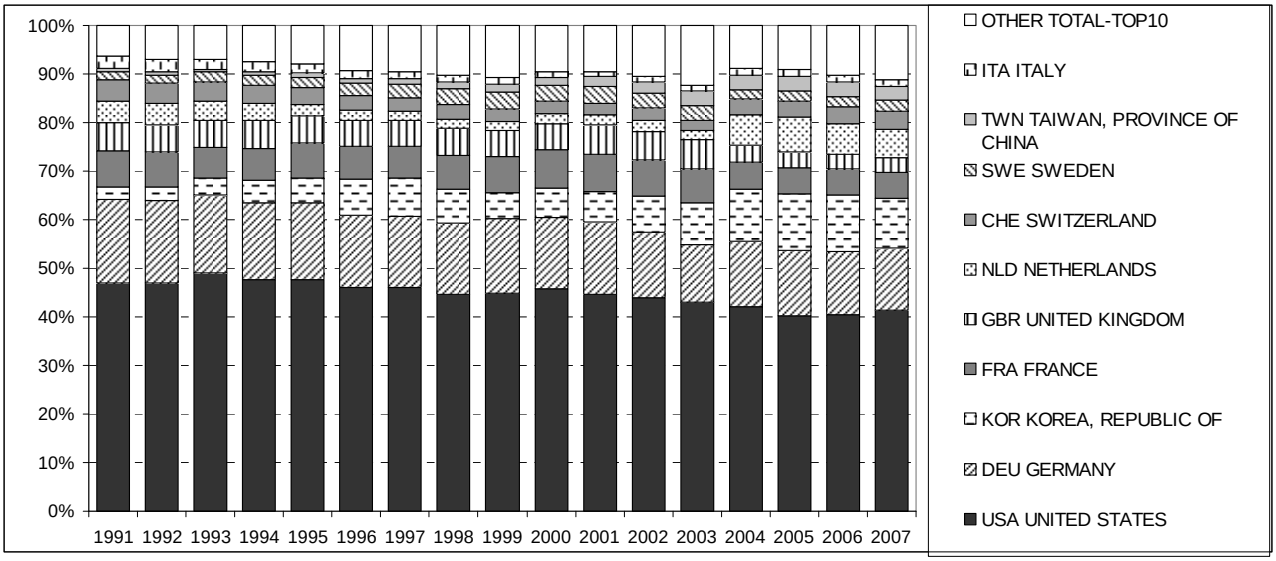
I collected data from several editions of the JPO Annual Report and created a dataset which includes all the countries which have applied for at least one patent or one utility model or one design or one trademark, in order to consider all the nations which have demanded for at least one kind of IPR to the JPO from 1991 until 2007. The resulting dataset is made of 147 countries.
Of them, 112 have submitted the request for at least one patent in the whole period; among these, 87 countries applied either 0 or 1 patent per year on average while only the U.S. applied for more than 10.000 patents per year on average. As it can be seen in *Figure 4* , nearly 60% of the selected countries didn't request any or made only one application in the whole period.

Figure 4 Count of countries per intervals of average yearly number of applications at the JPO in the period 1991 – 2007 and percentage on total countries applied for an IPR in the same period; line is the cumulative (source: several JPO Annual Reports)



The composition of non resident applicants at the JPO is presented in *Figure 5*. It shows the percentages of the top 10 countries in filing patent applications at the JPO. Their shares sum up to circa 90% of the total applications filed in but it is decreasing. If the top 20 countries are considered, the total represented share is yearly more than 97%. U.S. alone represents more than 40% of the total yearly applications but the percentage is decreasing through time, leaving room in particular to Republic of Korea and to the miscellaneous group which includes, among the others, countries like Canada, Australia, Denmark, Belgium, Austria, China, Spain, Russia, Brazil and India.

Figure 5 Share of the top 10 applicant countries to the JPO on total non-resident applications



5 Drivers to international patents

Scientific literature addressed the question of what have an impact on foreign patent application in several studies. Different approaches focus on different aspects but the variables affecting the propensity to patent abroad can be grouped in three main groups: the first describes the extending countries with their peculiar features, the second focuses on the recipient country and the third group evaluates the relations between the two involved countries, extending and receiving patents.

5.1 Extending country characteristics

The first group of characteristics aims at evaluating the innovativeness of the applicant countries. It accounts for extending country's characteristics, since nations are in different development stages with unique features. Each country has its own capacity to generate innovations and so patents. It is related to its wealth and ability in creating research output which is formalized in patent applications. Besides, each country have access to different amounts of human and economical resources and follows different strategies and policies in order to set its level of commitment to R&D. This determines different levels of research input with direct influence on the patent output. Some studies tried to measure the inventiveness of a country, as defined by Eaton and Kortum (1996) or the "National Innovation System", as in Grupp and Schmoch (1999), through education, industrial relations, technical and scientific institutions, government policies, cultural institutions and other variables. Furman et al. (2002) defined the particular system which generates patents using the term "Common Innovation Infrastructure", including both the resources which act as input and the real national infrastructure which act as the mean to create output.

5.1.1 Economic development stage: GDP per capita

The wealth of a nation, proxied by its GDP per capita, and its size, measured through population, capture the economic development stage and the national capacity to invest in research: both are found to be positively correlated to patent production (Eaton and Kortum, 1996; Grupp and Schmoch, 1999; Furman et al. 2002; van Zeebroeck et al. 2009).

5.1.2 Research effort: R&D expenditures

Research effort seems to have a significant relevance in the propensity to patent abroad in terms of absolute R&D expenditures or as a ratio on the GDP (Eaton and Kortum, 1996; Chada, 2009). However some studies[13] reported no significant impact of R&D intensity on patent propensity.

Other characteristics, not directly considered here, which have been found to affect the propensity to patent abroad are total stock of knowledge (Furman et al., 2002), level of the investments in education (Eaton and Kortum, 1996; Grupp and Schmoch, 1999; Furman et al., 2002; Varsakelis, 2006) and firm size[14] (Arundel et al., 1995; Kortum and Lerner, 1999; Arundel, 2001; Hanel, 2006; Blind et al., 2006).

5.2 Japan and the JPO

This second group of characteristics describes the attractiveness of the recipient country in terms of national macro economic features and variations in the cost of patenting.

5.2.1 Size and wealth of the recipient country: population and GDP per capita

Japanese consumption capacities are directly related to national wealth and market size which are measured through population and GDP per capita (Bosworth, 1984; O'Keefe, 2005).

5.2.2 Cost of patenting

Another relevant aspect of any national IP system is the cost of patenting. The cost of an international patent sums up the application and other office fees, the translation and the local patent attorneys' consultancy. Even if in Duguet and Kabla (1998) cost do not seemingly have an influence on patent decisions, other works found the opposite result. Macdonald (2004) stated that one of the major constraints is the cost of patenting but the increased value of the patent can dwarf these costs. Ordover (1991), Eaton and Kortum, (1996), Watanabe et al. (2001), Yang and Kuo, (2008) pointed out that a high cost can retain some applicants from patenting. de Rassenfosse and van Pottelsberghe de la Potterie (2008) found a negative elasticity in patent propensity when fees are raised.

5.3 Extending country – Japan relation

The propensity to apply for a patent in a foreign country is related to the level of economic involvement of a certain country in the recipient one and to their proximity. Proximity is meant not only in terms of spatial distance, even if some studies found it to be significant (MacGarvie, 2005; Perkins and Neumayer, forthcoming) but also in terms of technological closeness (MacGarvie, 2005) and IP systems harmonization (Kumar, 1996).

5.3.1 Technological proximity

Patenting activities are related to industrial sectors[15]. If the extending country shares with the recipient country a particular specialization in certain sectors, this should imply a higher propensity

[13] A wide review of literature is in the work of Lopez (2009).

[14] Even if it is not a unanimous finding, Small and Medium Enterprises (SME) seem to have less propensity to apply for patents. A country with an high percentage of SMEs could have consequently a less propensity to patent. Moreover, large firms often belong to an international group or are multinational enterprises with a precise global IP strategy: their propensity to patent abroad is higher. Lopez's review (2009) lists several articles with different results on the influence of firm size on patent propensity.

[15] Macdonald (2004) and Kanwar and Evenson (2008) highlighted the role of pharmaceutical firms while, in Blind et al. (2006) sector differences are said to be not so relevant.

to patent in that country. Eaton and Kortum (1996) stated that this can be viewed as the likelihood that inventions from the source can be adopted into the destination's technologies.

5.3.2 Economic involvement: trade and FDI

The economic involvement in the recipient country may have a significant role in the number of patents a foreign country files in. The involvement, that is the extent to which the production and the markets of any two countries are related, can be seen through the level of exports and of Foreign Direct Investments (FDI).

A higher amount of exports to a particular country implies a greater variety of transferred technologies, for which patent protection must be sought, and therefore a greater number of international patent applications. The role of trade in explaining the variations in the number of international patents has been treated in Bosworth (1984), Vishwasrao (1994), Grupp and Schmoch (1999), O'Keefe (2005) and Yang and Kuo (2008). The ownership of proprietary technology potentially provides firms wishing to export their products and services with a competitive advantage in foreign markets. Exporters are expected to attempt to protect their technology in foreign markets by filing for patent protection. Without patent protection, domestic competitors (as well as third countries operating in the same market) could well engage in copy-cat engineering, eroding a firm's core competitive advantages and causing significant commercial damage.

Similarly, higher inward stocks of FDI suggest greater foreign involvement in the host economy, bringing with it a larger number of proprietary technologies, which again is likely to lead to more filings by non-residents. Some studies which found a significant positive correlation between international patent applications and FDI are Bosworth (1984), Kumar (1996), Hoekman et al., 2004 and Yang and Kuo (2008). As outlined in models of strategic blocking, FDI may additionally be accompanied by attempts to "build walls" around foreign markets, with a view to deterring the entry of other competitors. Multinational enterprises may file for a large number of patents in particular technology fields, whether or not they intend to use or licence the technology, in countries where they operate. They may also file for patents in the host economy to facilitate interaction, transactions and co-operation with other firms.

Evaluating at the same time exports and FDI could be problematic, since they are not independent. It is not clear if trade and FDI, as noted in Maskus (1998), are substitute or complementary. In addition, Maskus (1997) remarks that Japan in relation to its GDP is a very small recipient of inward FDI but a large supplier of outward FDI.

Other characteristics, not directly considered here, which have been found to have an influence in propensity to patent abroad are the number of collaborations and joint ventures (Hanel, 2006; Ma and Lee, 2008) and researchers exchange (Eaton and Kortum, 1996)

5.3.3 IPR strength: patent protection index

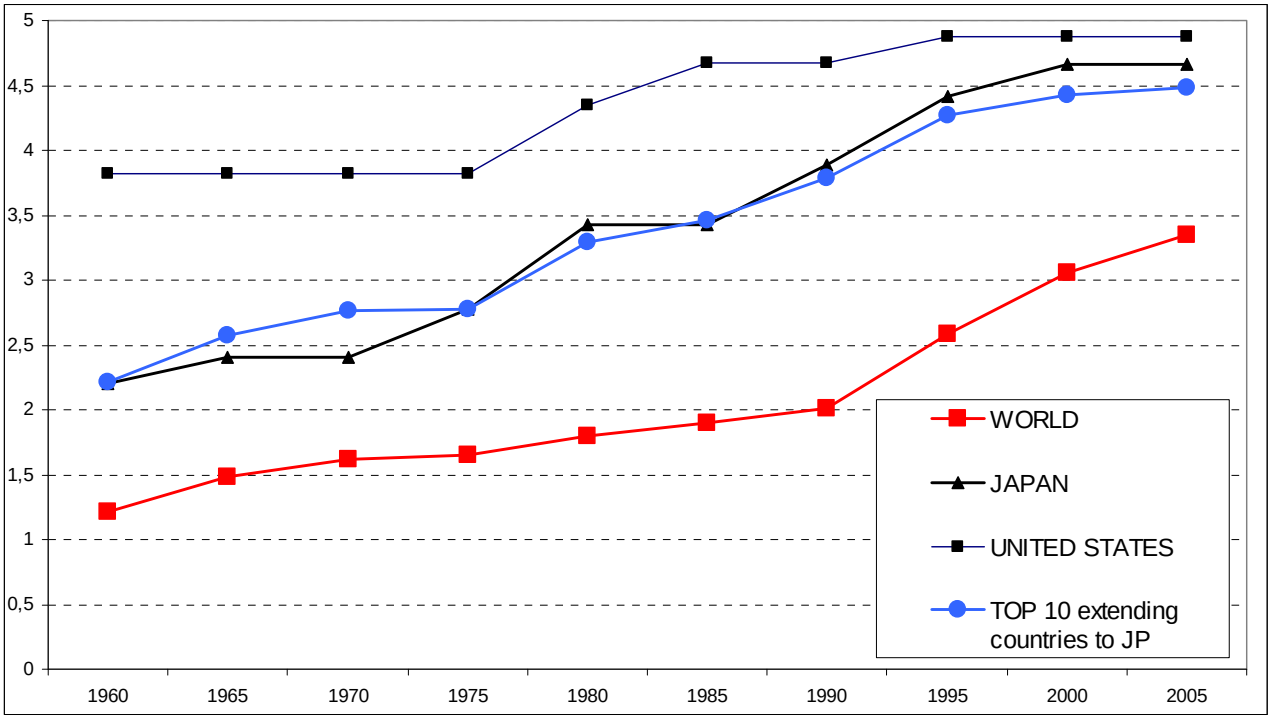
According to Ordover (1991) and Maskus (1998) IPR strength and an adequate level of protection and enforcement have a positive effect on the capacity to attract international patents. Similarly, Kumar (1996) found that an increasing IPR strength attracts more R&D only from industrialized countries.

The strength of an IP system has been defined and measured in different ways. Maskus (2000) analyzes some Patent Protection Indexes (PPI). Some of them are based on surveys such as the one in Lee and Mansfield (1996), Furman et al. (2002) or Porter and Schwab (2009): they try to estimate the IPR strength which is perceived by firms. Another type of measures includes the one defined by Rapp and Rozek (1990) and the one by Ginarte and Park (1997). They are based on a set of objective criteria.

The index realized by Ginarte and Park (1997) and recently updated by Park (2008) evaluates the level of patent protection and covers the longest period of time for the largest number of countries. Their Patent Protection Index (PPI) is made of five components, each scoring from 0 to 1. The five parts are: patent coverage in terms of allowed patentable subjects, maximum length of a patent,

membership in international treaties, enforcement and loss of rights. They calculated each country's PPI every five years starting from 1960 until 2005. *Figure 6* shows the variation of the index through time. Japan is below U.S., which has the highest level, but it is reducing the gap. By contrast, even if the world average is increasing too, the gap from Japan has increased. If the top 10 applicants to the JPO are considered, their average shows similar movements to Japan's PPI.

Figure 6 Patent Protection Index (World average, Japan, U.S. and top 10 non resident applicants at the JPO)



6 Methodology

The dependent variable is the number of patent applications filed at the JPO by each country every year from 1991 to 2005[16]. Since the count of filings can assume only positive integer values and it is affected by overdispersion (variance largely exceeds mean), I decided to use a negative binomial model for panel data. In order to take in consideration possible missed differences among countries, I opted for a fixed effects regression.
The selected model implies to keep in the analysis only those countries which have applied for at least one patent application in the considered period.
The independent variables try to capture the main characteristics of the three groups mentioned above. If not differently specified, data are extracted from the Structural Analysis database (STAN) realized by the Organisation for Economic Co-operation and Development (OECD)[17] or from United Nations (UN) databases[18] and currency unit is expressed in constant U.S. dollar.

In order to evaluate extending countries, population (POP) and GDP per capita (GDPPC) stand for proxies of the size and the development level. The commitment to R&D is expressed by the gross expenditures on R&D as ratio of the GDP (GERD[19]). These three variable are expected to have a positive influence on the number of international patents. To control for IP peculiarities of the

[16] Data have been collected from several editions of the JPO Annual Report.
[17] Available online: http://stats.oecd.org/wbos/Index.aspx?DatasetCode=STAN08BIS&lang=en .
[18] Available online: http://data.un.org .
[19] Since some data are missing, it has been linearly interpolated.

extending countries, patent protection (measured through PPI[20]) and propensity to patent abroad (PROP) are considered. The latter has been calculate as the sum of one country's applications at the EPO and patent grants at the USPTO, both by date of filing.
Japan's peculiarities are reflected by its population (POPJ) and its GDP per capita (GDPPCJ). The IP system proximity between Japan and each country or the level of harmonization of patent protection is captured by the variable HARMON which is calculated as the absolute value of the difference between Japan's and each country's PPI. Since it is an absolute value, its effect is expected to be negative, that is the lower the PPI distance between Japan and the extending country is, the higher the number of international filings is. Finally, a proxy for the cost of patenting is represented by EFEE, that is the entry fee an applicant has to pay when deciding to apply for a patent at the JPO[21].
Last set of variables tries to describe the economic involvement of one country in Japan, through the volume of export (TRADE) and the inward FDI[22] (FDI), controlling by the technological distance (TECHD). The latter variable has been calculated considering one country's EPO applications broken down by the 8 main IPC classes (one digit). Each class can be considered as one dimensional axis where positioning each country. The ratio of each IPC class patents on the total number of applications filed by that country represents the country positioning on one of the 8 axes. Each country can be positioned in the 8-dimensional technological space and it is possible to evaluate how "far" it is from Japan in terms of Euclidean distance. Countries which are technologically closer to Japan are expected to file more applications at the JPO.
Table 1 provides descriptive statistics of the mentioned variables.

Table 1 Descriptive statistics of variables

Variable	Obs	Mean	Std Dev	Min	Max
Foreign patent applications	2494	307.376	1833.513	0	26026.000
Population (Million inhabitants)	2738	37.256	134.229	0.009	1321.052
GDP per capita (Millions constant USD)	2466	7523.010	9477.003	43.858	55807.570
GERD (percentage of GDP)	1029	1.163	0.963	0.016	4.762
Patent protection index (PPI)	1553	2.926	1.085	0	4.875
Propensity to patent abroad (Thousands of patents at EPO and USPTO)	2626	1.124	8.493	0	134.980
Population of Japan (Million inhabitants)	2757	126.173	1.439	123.205	127.762
GDP per capita of Japan (Millions constant USD)	2757	36221.560	2170.275	31719.330	40820.270
Entry fee (Thousands constant USD)	2757	0.123	0.036	0.077	0.195
Harmonization of patent systems (difference in PPI)	1553	1.537	0.980	0	4.467
Trade (volume of export to Japan - Millions constant USD)	2681	2528.083	8271.802	0	106038.600
FDI (Millions constant USD)	919	187.760	1076.590	-6322.638	22083.780
Technological distance	2757	0.432	0.254	0	1.132

[20] Since it is originally calculated only every five years, it has been linearly interpolated.
[21] Data have been provided by de Rassenfosse and van Pottelsberghe de la Potterie (2008) and correspond to the yearly average entry fee paid by an applicant at the JPO.
[22] Data are collected from OECD's STAN database and from the statistics page available in the website of Japan Ministry of Finance of Japan: http://www.mof.go.jp/english/files.htm .

Table 2 Panel data - Negative binomial - Applications at the JPO per country per year

Model	(1)		(2)		(3)		(4)	
Observations	725		584		468		468	
Population	0.003	***			0.003	***	0.003	***
GDP per capita	0.020	***			0.014		0.014	
GERD	0.451	***			0.453	***	0.453	***
Patent protection index	0.625	***						
Propensity to patent abroad	0.002				0.001		0.001	
Population of Japan					0.016		0.012	
GDP per capita of Japan					0.046	*	0.048	
Entry fee							0.079	
Harmoniz. of patent systems			-0.675	***	-0.614	***	-0.614	***
Trade (volume of export)			0.013	***	0.001		0.001	
FDI			0.011		-0.006		-0.006	
Technological distance			-0.928	***	-0.594	*	-0.592	*
constant	-1.645	***	2.286	***	-2.137		-1.760	

7 Results

The analysis of regression results reports different conclusions in the three set of variables. The regressions run in this study show different numbers of observations because of data availability. In particular, data on R&D expenditures (GERD) and FDI are not traced for all the countries and years object of this work.

The set of variables which describes origin countries shows significant positive values in terms of size (measured through population) and commitment to R&D (GERD) when the econometrical analysis is run considering either only this type of variables only or all the variables. The development level, proxied by the wealth of country population (GDPPC) loses relevance when all the variables are considered but it still keeps a positive sign. The PPI of the extending countries proves positive significance. It is worth to be noted that in the regression, the propensity to patent abroad (PROP) is kept into consideration but it is not relevant even if it shows a constant positive sign.

The set of variables inherent to the recipient Office and Japan seems less relevant but for the level of harmonization of the IP system. The size of market, that is the Japanese population, (POPJ) and its consuming capability (GDPPCJ) have a positive sign but are not significant (only once GDPPCJ is slightly relevant). The entry fee (EFEE) does not show significance[23] while, on the contrary, the difference in PPI between Japan and each of the extending countries (HARMON) proved a robust negative sign: the more similar the IP system are when measured through the PPI, the higher the number of patent application extended from that country to the JPO is.

Finally the variables specifying some of the interactions between Japan and the rest of the world are less relevant. The technological distance (TECHD) is relevant with a negative sign, that is the closer the extending country and Japan are in terms of patented technology, the higher the number of filings is from that country to the JPO. Trade volumes (TRADE) and FDI report coefficient which are not significant (only in one case for TRADE while FDI presents changing sign) but it must be reminded that compared to other highly industrialized countries volumes of trade and FDI are quite low.

[23] I performed other tests including entry fee variable in combination with other set of characteristics reaching the same result.

7.1 Conclusion

This article aims to provide some insights to the reasons of the recent increase in foreign patent applications at the JPO. The variables I investigated can be grouped in different classes: macroeconomic values related to the extending countries and to Japan, patent system indexes and data on each exporting nation about its involvement in and proximity to the recipient country.
The characteristics of the extending countries which seems to positively affect the number of patent applications per year are mainly the size, the commitment to R&D and the strength and coverage of the domestic patent system, respectively proxied by population, gross expenditures on R&D and the Ginarte and Park patent protection index (Ginarte and Park, 1997 and Park, 2008). Less robust but still positive coefficients result from the analysis of extending countries' wealth, measured through GDP per capita. The propensity to patent in Japan is therefore related to the innovativeness of each origin country: when domestic investments in R&D grow and the domestic patent system reaches an higher level of PPI, the number of patent applications to the JPO rise, likely as direct consequence of a general increase in the number of patent filings in the origin country.
When the focus is set on the characteristics of the recipient Office and Japan, neither the size of the market nor its wealth, respectively measured through population and GDP per capita, report a significative coefficient. The proximity of the patent system to that of the extending country seems to facilitate the patent extension procedure: the harmonization of national patent systems in this sense play a facilitating role in the flow of patents from one country to another. The level of harmonization is measured in terms of distance between the PPIs. The patent fee does not present significative values, but the values used in the analysis are calculated as average of all the filings at the JPO: since it includes both domestic and foreign patents, it is not a precise measurement.
The involvement of each extending country in Japan, accounted by FDI and trade volumes, does not report a clear correlation with the number of filings at the JPO. It is worth reminding that inward flows of investments are low if compared to other industrialized countries and so even small variations in the yearly amounts can change the trend of FDI. Besides the same FDI data are not available for all the countries in all the years considered.
Future research may clarify the role of the variables considered by extending the number of recipient offices and increasing the number of observations by gaining more data on variables such as R&D expenditures and FDI.

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